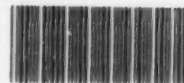


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41.D

- ARCTIC SHIP TECHNOLOGY -
PROBABLE ARCTIC SHIPPING SCENARIOS
TO THE YEAR 2000

TDC Project 6555
TDC File D1460-227

by

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433-20

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1.0 INTRODUCTION AND SUMMARY

The Transportation Development Centre has commissioned an investigation of the state-of-the-art of arctic ship technology. The investigation must review our understanding of the design and operation of arctic ships. Since the final report will be almost wholly technical, it is important to place into perspective this very detailed information by also reviewing the probable shipping scenarios which may place demands on the technology over the next 15 years.

This report documents an extensive investigation of arctic resources, of how they may be developed, and how marine transportation may play a role. Government shipping activities are also reviewed. The report is subdivided into several sections:

a) Review of arctic activity

A review is completed of the present and potential arctic activities in the areas of mineral and oil and gas exploration and development and government shipping. The results of discussions with many industry and government contacts are presented and the likelihood of projected activities is assessed.

b) Probable arctic shipping scenarios

The projected activities are reviewed in depth to define the probable shipping requirements. The shipping systems which may be required for those projects which could occur before the year 2000 are outlined, with cautionary notes to qualify or soften the projections.

c) Technology requirements

Comments are offered on how our understanding of arctic ship technology must be developed along with, or in advance of, the planning for major arctic resource projects.

The review and assessment of probable projects and associated shipping requirements is presented as a 'focus' for the work being done for the Transportation Development Centre, i.e., to document the state-of-the-art in Arctic Ship Technology. The probable arctic shipping scenarios offer an informed view or opinion on the type and size(s) of vessels which may be required. These vessels can create boundaries within which the technology may be documented, and within which further research programmes may be structured.

2.0 REVIEW OF ARCTIC ACTIVITY

The present activity and potential future developments may be divided into three areas:

- Mineral exploration and development;
- Oil and gas exploration and development;
- Government activity.

Only the current and forecasted activities as they might impact on marine transportation, are discussed and the projections of potential developers, in conjunction with input from government departments and various studies and publications, have led to conclusions in each area.

2.1 Mineral Exploration and Development

Those companies who are involved in the development of mineral resources and who have been contacted during this investigation are:

Aberford Resources
Borealis Exploration Ltd.
Canarctic Shipping Company Limited
Cominco Limited
Conwest Exploration Co. Ltd.
Fednav Limited
Gulf Canada Resources Ltd.
Kidd Creek Mines
Nanisivik Mines Limited
Noranda Mines Ltd.
Petro-Canada
Sulpetro Minerals Limited
Urangesellschaft Canada Limited
Westmin Resources Ltd.

The opinions and projections of these organizations, supplemented by various publications and by in-house expertise have been used to develop the following review.

2.1.1 Operating Mines

Nanisivik Mines Limited and Cominco Limited are the only two major operators in the Arctic whose product is transported by ship. Details of the operations at the Polaris and Nanisivik mines are shown on Figure 2.1.

a) Nanisivik Mines Limited

The Nanisivik Mine has been in operation since 1977 and currently has an output of about 150,000 tonnes of lead and zinc concentrates per year. It is envisaged that production can continue from the current site for another five to eight years.

FIGURE 2.1
MINES WHICH USE
MARINE TRANSPORTATION

POLARIS MINE

OPERATOR
LOCATION

COMINCO LIMITED
LAT 75 26
LONG 96 25

RESERVES (ORE 1982) 25.5 MILLION TONNES
ANNUAL QUANTITY 225 - 300,000 TONNES

SHIPMENT
SHIPPING SEASON

AUGUST - OCTOBER

NANISIVIK MINE

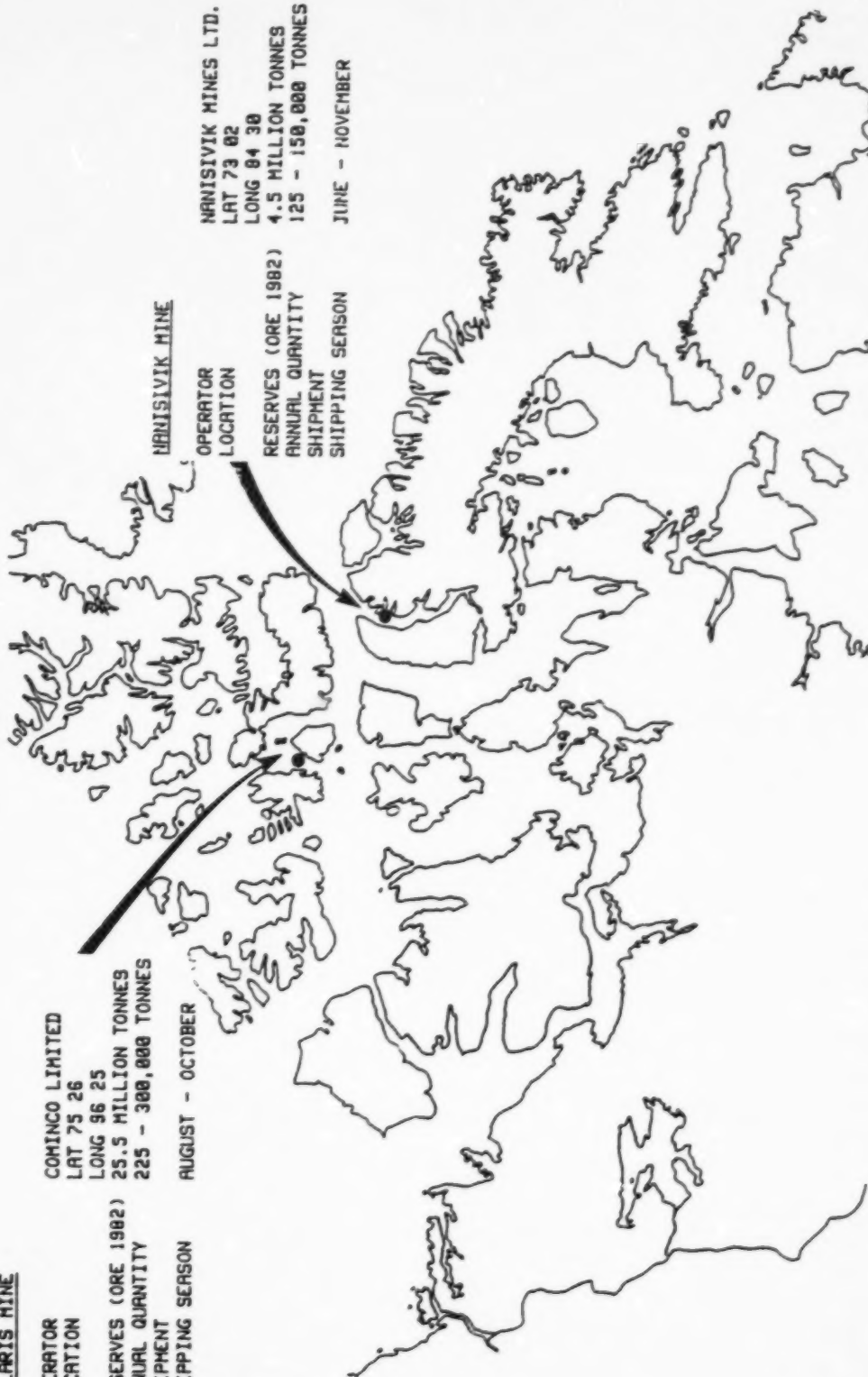
OPERATOR
LOCATION

NANISIVIK MINES LTD.
LAT 73 02
LONG 84 30

RESERVES (ORE 1982) 4.5 MILLION TONNES
ANNUAL QUANTITY 125 - 150,000 TONNES

SHIPMENT
SHIPPING SEASON

JUNE - NOVEMBER



The mine operates year-round, stockpiling concentrates for the short shipping season from late June to mid November. Nanisivik Mines Limited and the operator, Mineral Resource International Limited, are looking for additional reserves, but have yet to find sufficient quantities to warrant additional development.

b) Cominco Limited

Cominco Limited owns and operates the Polaris mine on Little Cornwallis Island, the world's most northerly mine. The mine commenced operation in 1982 and was anticipating reserves to sustain annual shipments of 250-300,000 tonnes per year well into the next century. Annual shipments are currently about 230,000 tonnes and are moved between early August and mid October. Production will not increase beyond 300,000 tonnes per year due to constraints in the production equipment and other problems associated with extending the transportation season.

The cost advantage which these two properties have over other lead zinc mines is their proximity to relatively inexpensive ocean transportation. Although base metal markets have weakened, both of these operators envisage current production levels for at least the next few years.

2.1.2 Potential Projects

Table 2.1 and Figure 2.2 present details of various Arctic sites which have been investigated for possible development. In each case the property operator was contacted to ascertain the likelihood of development prior to the year 2000. In many cases mineral properties are located too far from the coast to utilize ships for transporting the ore, even for resupply. These projects are omitted from the list as are those where development clearly would not be contemplated within the next 15 years.

The list shows the property name, a reference number from Figure 2.2, and estimated compositions and quantities taken from the Indian and Northern Affairs Canada (INAC) publication, "Mines and Important Mineral Deposits of the Yukon and Northwest Territories, 1982". This publication presents the most up-to-date inventory of mine reserves and important mineral deposit resources in the north.

The table presents the properties according to the type of mineral and this is how they are addressed in the following text.

a) Base Metals

The present world markets for base metals are poor with prices generally being depressed. Three types of base metals may be identified; lead, zinc and copper.

Some of the organizations contacted do not anticipate being the "first" lead/zinc development in the area, but expect that development

TABLE 2.1

NORTHWEST TERRITORIES MINERAL DEPOSITS
WHICH MAY REQUIRE MARINE TRANSPORTATION

MAP REF #	DEPOSIT	OWNER	COMPOSITION	RESERVES (MM Tonnes)
<u>BASE METALS</u>				
1	ECLIPSE LAT 75°32' LONG 96°10'	Cominco Limited	Lead 12.40% Zinc. 2.18%	1.40
2	HACKETT RIVER AREA			
	a) A Zone LAT 65°55'00" LONG 108°22'00"	Bathurst Norse- mines Limited and Cominco Limited	Zinc 8.50% Lead 1.40% Copper 0.25% Silver 240 g/t Gold 1.70 g/t	3.63-4.50
	b) Boot Lake LAT 65°54'55" LONG 108°25'50"	Bathurst Norse- mines Limited and Cominco Limited	Zinc 4.97% Lead 0.99% Copper 0.29% Silver 201 g/t Gold 0.50 g/t	4.50
	c) Cleaver Zone LAT 65°55'55" LONG 108°27'30"	Bathurst Norse- mines Limited and Cominco Limited	Zinc 7.07% Lead 1.04% Copper 0.45% <u>and</u> Zinc 1.08% Lead 0.84% Copper 0.48% Silver 33.30 g/t	3.63
3	HENINGA LAKE LAT 61°46'25" LONG 96°12'10"	Sulpetro Minerals Limited	Zinc 9.00% Copper 1.30% Silver 68.60 g/t Gold 1 g/t	5.44
4	HIGH LAKE			
	a) D Zone LAT 67°46'25" LONG 110°51'10"	Kennco Explorations (Canada) Limited	Zinc 3.60% Lead 0.20% Copper 2.00% Silver 37.70 g/t	2.54
	b) AB Zone LAT 67°46'25" LONG 110°51'10"	Kennco Explorations (Canada) Limited	Copper 5.40% Zinc 1.10%	2.18

TABLE 2.1 (continued)

NORTHWEST TERRITORIES MINERAL DEPOSITS
WHICH MAY REQUIRE MARINE TRANSPORTATION

MAP REF #	DEPOSIT	OWNER	COMPOSITION	RESERVES (MM Tonnes)
5	IZOK LAKE LAT 65°38'00" LONG 112°47'45"	Kidd Creek Mines Limited	Zinc 13.77% Lead 1.42% Copper 2.82% Silver 70.30 g/t	11.00
6	MUSK LAT 65°19'30" LONG 107°32'	Noranda Mines Limited	Zinc 10.0% Lead 1.40% Copper 1.20% Silver 342.80 g/t	0.34
7	YAVA LAT 65°36' LONG 107°55'	Conwest Exploration Limited Westmin Resources Limited	Zinc 5.00% Lead 1.50% Copper 0.60-1.50% Silver 103-137 g/t Gold 0.34 g/t	1.13
<u>COAL</u>				
8	BAY FIORD LAT 79°04' LONG 82°00'	Petro-Canada Limited	Lignite	unknown
9	COAL MINE LAKE LAT 68°42' LONG 136°19'	Petro-Canada Limited	Sub-bituminous S	unknown
10	MEADOW RIVER LAT 77°58' LONG 81°41'	Petro-Canada Limited	Lignite	unknown
11	MIDDLE KANGUK LAT 79°16' LONG 91°10'	Gulf Resources Limited	Bituminous C to Sub-bituminous A	unknown
12	SLIDRE FIORD LAT 79°57' LONG 85°10'	Gulf Resources Limited	Sub-bituminous	2,000
<u>IRON</u>				
13	a) BOREALIS EAST LAT 68°28'05" LONG 82°43'00"	Borealis Exploration Limited	Iron 23-34%	1,100

TABLE 2.1 (continued)

NORTHWEST TERRITORIES MINERAL DEPOSITS
WHICH MAY REQUIRE MARINE TRANSPORTATION

MAP REF #	DEPOSIT	OWNER	COMPOSITION	RESERVES (MM Tonnes)
	b) BOREALIS WEST LAT 68°13'00" LONG 85°29'54"	Borealis Exploration Limited	Iron 32-38%	3,200
14	MARY RIVER LAT 71°19' LONG 79°21'	Baffinland Iron Limited	Iron 68% Iron 30%	260 500
<u>URANIUM</u>				
15	AMER LAKE LAT 65°32'54" LONG 96°45'12"	Aquitaine Company of Canada Limited	Uranium* Molybdenum*	unknown
16	BAKER LAKE AREA a) North Shore LAT 64°10'11" LONG 94°33'25"	Aberford Resources Limited	Uranium 0.13-0.81% Molybdenum*	unknown
	b) Bissett Creek LAT 63°47'51" LONG 95°07'44"	Aberford Resources Limited	Uranium n.a.*	unknown
	c) Christopher Island LAT 64°04'35" LONG 94°32'53"	Aberford Resources Limited	Uranium 0.04% Molybdenum*	unknown
	d) Kazan Falls LAT 63°41'25" LONG 95°46'41"	Aberford Resources Limited	Uranium 0.46%	unknown
	e) Kazan River LAT 63°48'22" LONG 95°33'18"	Aberford Resources Limited	Uranium n.a.*	unknown
	f) Kazan River LAT 63°48'59" LONG 95°35'09"	Aberford Resources Limited	Uranium n.a.*	unknown
17	LONE GULL LAT 64°27' LONG 97°36'	Urangesellschaft Canada Limited	Uranium 1.00% Lead trace - 50%	unknown

* Mineralization Grade Not Available.

TABLE 2.1 (continued)

NORTHWEST TERRITORIES MINERAL DEPOSITS
WHICH MAY REQUIRE MARINE TRANSPORTATION

MAP REF #	DEPOSIT	OWNER	COMPOSITION	RESERVES (MM Tonnes)
18	LAC CINQUANTE LAT 62°32' LONG 98°38'	Aberford Resources Limited	Uranium*	unknown
19	PEC LAT 67°16'18" LONG 116°56'	Aquitaine Company of Canada Limited Cominco Limited	Uranium*	unknown
20	YUK LAT 67°18' LONG 116°51'	Esso Minerals Limited	Uranium 0.26-1.00% Copper up to 5%	unknown

* Mineralization Grade Not Available.

FIGURE 2.2

MINERAL DEPOSITS WHICH MAY REQUIRE
MARINE TRANSPORTATION



BASE METALS

- 1 ECLIPSE
- 2 HACKETT RIVER
- 3 HENINGA LAKE
- 4 HIGH LAKE
- 5 IZOK LAKE
- 6 MUSK
- 7 YAVA

COAL

- 8 BAY FIORD
- 9 COAL MINE LAKE
- 10 MEADOW RIVER
- 11 MIDDLE KANGUK
- 12 SLIDRE FIORD

IRON ORE

- 13 BOREALIS EAST AND WEST
- 14 MARY RIVER

URANIUM

- 15 AMER LAKE
- 16 BAKER LAKE
- 17 LONE GULL
- 18 LAC CINQUANTE
- 19 PEC
- 20 YUK

PRECIOUS METALS

- 21 VARIOUS LOCATIONS
NEAR SHORE

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of their property may occur following the lead of a site; richer in ore, better geologically defined or nearer to a suitable port location.

There are two specific areas near the northern shoreline of the Northwest Territories on which extensive exploration has occurred for lead and zinc. These areas are generally referred to as Izok Lake and Hackett River. Although quite near each other, it is probable that these two areas would develop separately. There are two options for moving the ore south;

- constructing a roadway south to Yellowknife and utilizing the existing infrastructure, or,
- constructing a roadway north to a suitable port location where ships would transport the concentrate to markets on a seasonal basis.

Marine transportation, from both locations, assumes year-round production from the mine sites, stockpiling at a shore location, and shipping during the open water or extended open water season. The ship used would be similar to the ARCTIC, as draft restrictions along the route (east or west) would preclude the use of a much larger vessel. Shipments of 150-300,000 tonnes per year could be possible from this area using ships of 25-30,000 tonnes during an extended shipping season from early August to mid October.

The area on the western shore of Hudson Bay at Ferguson Lake and Henninga Lake has promising copper nickel and copper zinc reserves. The exploration sites are located inland and transportation is required to a suitable port. It is unlikely that the property at Ferguson Lake will be developed unless the ore can be processed at the site. The ore at Henninga Lake includes precious metals and the project sponsor is hopeful that development will occur to take advantage of all the minerals present. This type of development is very attractive to the mining companies because it eases their dependence on a single metal market.

Several high grade copper reserves have been found near Coppermine. However, there is currently little active exploration.

b) Coal

There is an abundance of coal throughout the Arctic, located near shore and accessible by ship. Many deposits have been identified on Ellesmere Island but the operators contacted did not foresee development until well after the year 2000.

c) Iron Ore

Development of some iron ore properties are considered, by the operators to be viable within the next 15 years. Borealis

Exploration is the most active in this area, with ore reserves also contain zinc. This may permit seasonal development based on shipping more than one product. Considering the readily accessible supplies of iron ore in Brazil, it is unlikely that arctic properties will be developed within the time frame of this investigation.

d) Uranium

The development of uranium properties is well advanced in the Baker Lake area and production will probably occur during this century. The ore will probably be concentrated on site and flown to southern refineries.

e) Precious Metals

There are vast reserves of precious metals in the Arctic. The high value metals are usually processed on site and although a large amount of equipment will be required to construct the processing plant, the requirements will be easily handled by existing tonnage or transported to the mine locations by land or air.

f) Rock Quarry

Another mining project which may be developed, and which may utilize ships, is the rock quarry proposed in the vicinity of King Point, Yukon. This project would require ships to operate during the open water season to deliver rock for the construction of artificial islands in the Beaufort Sea. Development of this property is highly dependent on the method of production and locations of wells in the Beaufort Sea.

2.1.3 Present and Potential Shipping

The shipping requirements of the operating mines are primarily handled by the M.V. ARCTIC and several lower ice class ships. The ARCTIC was constructed in 1978 as an Arctic Class 2, 28,000 dwt bulk carrier and is operated by Canarctic Shipping Company Limited. Modifications completed from 1984 through 1986 upgraded the vessel to an equivalent Class 4 OBO (ore, bulk, oil) allowing it to carry crude oil and bulk and ore cargoes.

There is a requirement for the resupply of operating mine sites and communities throughout the Arctic. This is generally accomplished during the open water season either by the Transport Canada "sea lift" or by private contract. The volumes shipped are not significant and would not play a major role in the design criteria for a new and higher ice class vessel.

Table 2.2 and Figure 2.3 provide a list of present and potential projects which involve transportation by ship. It is likely that some new tonnage will be required by the year 2000. If Cominco have the reserves and wish to produce after the late 1990's then a replacement vessel

TABLE 2.2

CURRENT OR POTENTIAL MINING DEVELOPMENTS
REQUIRING MARINE TRANSPORTATION

PROJECT NAME	PROPONENT	PROJECT LIFE	POTENTIAL SHIPS REQUIRED
<u>POTENTIAL MINING DEVELOPMENTS</u>			
Borealis Mine	Borealis Exploration Ltd.	*	existing tonnage
Hackett River	Cominco Limited	*	arctic class bulk carrier similar to the ARCTIC
Heninga Lake	Sulperetro Minerals	10 years+	existing tonnage
Izok Lake	Kidd Creek	15 years+	arctic class bulk carrier similar to the ARCTIC
Kiewit Quarry	Peter Kiewit and Sons Co. Ltd.	*	this project would require the use of a marginally ice classed bulk carrier
<u>OPERATING MINES</u>			
Little Cornwallis	Cominco Limited	15 years+	arctic class bulk carrier in conjunction with lower ice class vessels
Nanisivik	Nanisivik Mines Limited	5-8 years+	arctic class bulk carrier in conjunction with lower ice class vessels

* Project reserves and timing are yet to be fully defined

FIGURE 2.3

PRESENT AND POTENTIAL MINING DEVELOPMENTS
TO THE YEAR 2000



OPERATING MINES

1. LITTLE CORNWALLIS
2. NANISIVIK

PROPONENT

- COMINCO LIMITED
NANISIVIK MINES LIMITED

POTENTIAL DEVELOPMENT

3. BOREALIS MINE
4. HACKETT RIVER
5. HENINGA LAKE
6. IZOK LAKE
7. KIEWIT QUARRY

- BOREALIS EXPLORATION LTD.
COMINCO LIMITED
SULPETRO MINERALS
KIDD CREEK
PETER KIEWIT AND SONS CO. LTD.

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will be required similar to the ARCTIC. If properties such as Izok Lake or Hackett River are developed, using ships to transport the concentrate, then an "ARCTIC" size of vessel may be required.

The development of properties along the west shore of Hudson Bay may require ice class vessels for extended season operations. Without considerable dredging, the relatively shallow shoreline would require the use of ships in the 25-50,000 dwt range.

2.2 Oil And Gas Exploration And Development

Those exploration companies and Arctic ship operators who are involved with oil and gas exploration and development and have been contacted during this investigation are:

Arctic Transportation Limited
Canarctic Shipping Company Limited
Dome Petroleum Limited
Esso Resources Ltd.
Fednav Limited
Gulf Canada Resources
Monenco
Panarctic Oils Limited
Petro-Canada
TransCanada Pipelines Limited

The opinions and projections of these organizations, supplemented by various publications and by in-house expertise have been used to develop the following review.

2.2.1 Current Exploration

Oil and gas exploration in the Canadian Arctic has been underway for 25 years. During the early 70's it was thought that gas from the high Arctic would lead development, but as the gas surplus in the south became apparent, attention has focused on the development of oil reserves. The ongoing exploration activity in the Beaufort Sea and high Arctic are shown on Figures 2.4 and 2.5.

2.2.2 Potential Projects

Potential projects are discussed in the following notes for each of the operators presently proposing some level of development.

a) Esso Resources Ltd. - On and Near-Shore Oil

Esso has recently completed the Norman Wells pipeline which takes 25,000 bbl/day from Norman Wells in a 12 inch line to the Rainbow pipeline system at Zama, Alberta. This system could be expanded along the Mackenzie River to take an additional 25,000 bbl/day from onshore oil reserves. This is the most probable next step in Beaufort Sea development and would be proposed should a pool

FIGURE 2.4
BEAUFORT SEA
EXPLORATION

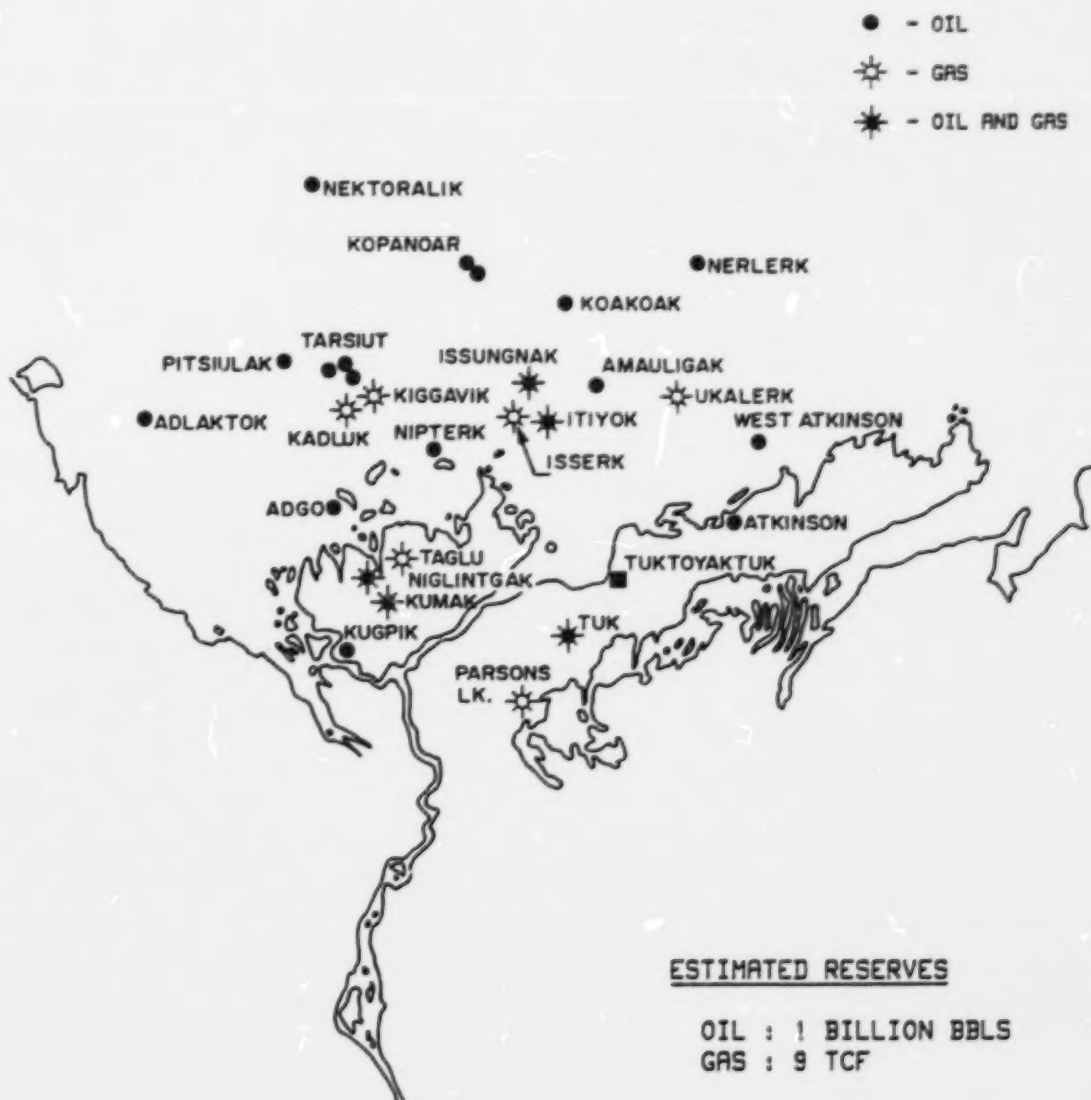


FIGURE 2.5
SIGNIFICANT HIGH ARCTIC
DISCOVERIES



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containing in excess of 100 million barrels be discovered "on" or "near" shore. Deeper water production locations would require higher production rates and a larger pipeline because of the higher capital costs.

Esso has considered the use of marine transportation for seasonal shipments and believe it to be impractical due to limited water depth near shore.

b) Gulf Canada Ltd. - Near-Shore Oil

Gulf anticipate that the Amauligak site will be suitable for development, and deliniation is in progress. Estimates of possible reserves range from 300-800 million bbls, which could justify construction of a large diameter pipeline with a throughput of 75-100,000 bbls/day. If reserves are sufficiently large, Gulf would utilize 100% of the pipeline capacity for their Amauligak location, although the line could be shared initially with Esso and later with Dome. Gulf estimate a lead time of four to six years to have the necessary infrastructure in place. It is probable that this development will occur in the early to mid 1990's.

If reserves are inadequate to satisfy the economics of a large diameter pipeline then a shipping system may be appropriate. A 100-300 million bbl pool could be transported by a shipping system using a dedicated Arctic class tanker.

Prior to full scale development at Amauligak, early production is being considered for 20-30,000 tonnes (150-225,000 bbls) of oil, commencing as early as 1986. This quantity could be shipped using existing vessels.

c) Dome Petroleum Ltd. - Offshore Oil

Dome have promising discoveries such as those at Adlartok, located in deeper water. Due to the deep water locations, the required facilities would result in increased costs. As a result it is unlikely that they will be the first to develop Beaufort Sea oil.

Dome have proposed the use of Arctic class tankers because the deep water locations suit this form of transportation. Unless substantial reserves are present, the construction of buried pipelines and gathering systems in this area are thought to be prohibitively expensive.

d) Gulf and Esso Gas Plants - On and Near-Shore

Both Gulf and Esso have proposed the construction of gas plants to supply the southern leg of the Polar Gas pipeline. This pipeline is proposed at 36 inches with throughput of 800 MCF/day. The gas would be supplied by wells located on or near shore on the Mackenzie River Delta. This pipeline and plant construction would require materials and modules to be brought in by ship and/or barges.

e) Panarctic Oils - High Arctic Oil

Panarctic Oils Company Limited are currently concentrating their efforts on production at Bent Horn, and deliniation of the Cisco reserves. They are undertaking other exploration and feasibility studies, but are not presently pursuing any other locations for development.

It is probable that shipments similar to those made from Bent Horn will occur for the next few years with a possible expansion from 100,000 bbls up to 500,000 bbls annually. This volume can be moved in the "summer" season of about 30 days.

The next major step in development will probably be production from Cisco. It is projected that development could occur with a production rate of 50,000 bbls/day, year-round. This oil would be moved south in either a single large tanker (1.5 million bbls) or a number of smaller vessels. The larger vessel has the advantage of a lower cost per barrel, but the smaller vessels may be a more reliable and system. The development of Cisco is thought to be practical between now and the year 2000, but is highly dependent on world energy demand and pricing.

f) Polar Gas Project - High Arctic Gas

The Polar Gas pipeline would access high Arctic gas and connect into the proposed 36 inch Mackenzie Valley pipeline. As with all energy developments, it is highly price dependent and development will only occur if commercially viable. It is unlikely that high Arctic gas will move south before the year 2000.

g) Arctic Pilot Project - Melville Island

The APP is presently on hold until gas markets and pricing are more attractive to the developers. This project involved the use of two 140,000 cubic metre Arctic Class 7 ships to deliver 1.9 MM

BCF of gas per year from Melville Island, NWT, to southern markets for a project life of 20 years. It is estimated that a six year start-up will be required to proceed with the project. Should world gas prices increase the project could proceed prior to the year 2000.

h) TransCanada Pipelines Limited - King Christian Island Gas

TransCanada Pipelines Limited, in conjunction with Panarctic Oils Limited, have proposed development of the King Christian Island reserves. This project is unlikely to be developed before the APP and will likely occur after the year 2000.

i) Methanol Project - Melville Island Methanol

Proposals have been put forward to process gas on Melville Island to produce methanol. The product would be transported to

western Europe in Arctic class tankers. Currently there are no specific development plans or active sponsors of this proposal.

2.2.3 Present and Potential Shipping

The potential projects which relate to oil and gas development are shown in Table 2.3 and Figure 2.6.

Currently there are several companies operating supply boats and drilling equipment in the Arctic, but movement to and from the Arctic is limited to the open water season. When development occurs it is likely that additional supply boats, barges and other support equipment will be required.

There is one large tanker operating in the Beaufort Sea, the GULF BEAUFORT, operated by Beaudril. This vessel is used as a supply base and for accommodation, but its major function is fuel storage. The vessel is ice strengthened, but cannot operate extensively beyond the open water season.

The ARCTIC is the only vessel which has moved commercial quantities of oil from the Arctic. This vessel lifted 100,000 bbls from Panarctic's Bent Horn site during August 1985 and is expected to complete similar voyages over the next few years. although quantities could increase to 500,000 bbls.

Tankers may be required for transportation of oil if Beaufort Sea discoveries are not sufficient to justify construction of a pipeline, or for small scale production. Systems based on vessels from 50-250,000 dwt have been discussed, and seasonal deliveries of 25-50,000 tonnes are possible utilizing existing tonnage. There are three potential scenarios which could develop;

- Arctic class shuttle tankers moving from the production/storage location to Lancaster Sound for transshipment.
- Small, Arctic class tankers delivering directly from the production/storage location to southern markets throughout the year.
- A single, large, Arctic class tankers delivering directly to market from year-round operation.

Redevelopment of the Arctic Pilot Project is the most likely of the gas transportation projects to occur prior to the year 2000. This project required the use of two 140,000 cubic metre, Arctic Class 7 vessels.

Production of onshore or offshore reserves in the Beaufort Sea or high Arctic would require a variety of equipment to be brought in to the production sites. The most likely method of transportation is by ocean barge.

TABLE 2.3
CURRENT AND POTENTIAL OIL AND GAS DEVELOPMENTS
REQUIRING MARINE TRANSPORTATION

PROJECT NAME	OPERATOR/ PROponent	PROJECT LIFE	POTENTIAL SHIPS REQUIRED
<u>CURRENT PROJECTS</u>			
Beaufort Sea Exploration	Dome; Gulf; Esso	5 years+	existing tonnage
Arctic Islands Exploration	Panarctic	5 years+	existing tonnage
Norman Wells Project	Interprovincial Pipelines (NW) Ltd; Esso	10 years+	existing tonnage
Bent Horn Oil	Panarctic	3 years+	existing tonnage
<u>POTENTIAL DEVELOPMENTS</u>			
a) Beaufort Sea			
Beaufort Oil Production	Gulf; Esso; Dome	10 years+	arctic class vessels may be required.
Norman Wells Oils Pipeline Extension	Esso	10 years+	existing tonnage
Mackenzie Valley Oil Pipeline	Gulf	15 years+	existing tonnage
Mackenzie Delta Topping Plant	Dome; Gulf; Esso; Inuvialuit Development Corp	10 years+	existing tonnage
King Point	Monenco	*	low ice class bulk carrier
Mackenzie Delta Gas Plants	Esso; Gulf	10 years+	existing tonnage

* Potential Development Undefined

FIGURE 3.2

SEASONAL SHIPPING OPPORTUNITIES
TO THE YEAR 2000



	ICE CAPABILITY	VESSEL SIZE	SHIPS REQUIRED	SHIPPING SAFETY ZONE	SEASON
MINERAL PROPERTIES					
1. IZOK LAKE	FIRST YEAR	20-30,000 DWT	1+	6	AUG - OCT
2. HENINGA LAKE	FIRST YEAR	20-30,000 DWT	1+	15	JUN - DEC
3. NANISIVIK	FIRST YEAR	20-30,000 DWT	1+	13	JUL - NOV
4. POLARIS	FIRST YEAR	20-30,000 DWT	1+	6	AUG - OCT
BEAUFORT SEA OIL					
5. SEASONAL PRODUCTION	MINIMAL	20-50,000 DWT	1+	12	AUG - SEP
6. EXTENDED SEASONAL PRODUCTION	FIRST YEAR	20-50,000 DWT	1+	2	AUG - OCT
HIGH ARCTIC OIL					
7. BENT HORN	FIRST YEAR	20-30,000 DWT	1+	1	AUG

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f) Beaufort Sea, Seasonal

Small volumes of 20-50,000 tonnes can easily be produced and transported from the Beaufort Sea during the open water season. Any small scale open water shipping requirements can be handled by existing tonnage. Larger scale seasonal requirements may involve the use of ice class tankers or barges. Shipping systems which use existing tonnage or modified existing tonnage are feasible for moving up to 150,000 tonnes per year.

g) Beaufort Sea, Small Scale Production

Should 100-300 million bbls of oil be discovered offshore, a 50,000 dwt Arctic class vessel could be used to transport the oil on a year-round basis. A system using storage facilities in the Beaufort Sea could be used or the Arctic class vessel could navigate to the ice edge for transshipment.

h) Beaufort Sea, Large Scale Production

Should offshore oil be located in sufficient quantity to justify large scale development, 200,000 dwt vessels have been proposed for year-round operation. These vessels might be supplemented by ice class tankers or tranship their cargo to ice class vessels in Lancaster Sound. The system would be highly dependent on the quantity to be shipped and the tariff available.

i) High Arctic Oil

Two vessel sizes have been discussed for the year-round production of oil from the high Arctic, assuming similar production rates:

- two 100,000 dwt Arctic class vessels,
- one 200,000 dwt Arctic class vessel.

Either of these vessels would be capable of year-round operation from the Lougheed Island area and could transport 2-2.5 million tonnes annually. The two ship system will be more costly but has the advantages of reliability and safety.

4.0 TECHNOLOGY REQUIREMENTS

The vessels which may be required for future Arctic shipping scenarios range from a conventionally powered seasonal ore carrier to high powered year-round oil or gas carriers. The technology required for these ships is presently evolving and will require further development to ensure the ships can be designed, built, and operated with confidence. Those areas of arctic ship technology which are of most importance to these future projects include:

- The development of ship navigation equipment and procedures which are specifically directed at navigation in ice. Assistance with strategic, tactical, and local navigation has, and will, pay great dividends in terms of ship efficiency and season length.
- The development of ship design criteria. These requirements should cover the important areas of; structure, propulsion, and general ship's equipment, and should pay particular attention to ship and personnel safety considerations.
- The development of ship performance prediction techniques which can be used with confidence. These techniques can include purely theoretical approaches, model testing, and a combination of these with the full scale testing of existing ships.

Arctic marine research and development in Canada is presently at a crossroads. Previous research efforts were driven to a great extent by the Arctic Pilot Project and Beaufort Sea developments. These developments have slowed to keep pace with oil and gas market demand and the pace of Arctic R & D is now being reviewed.

The experience of the last ten years has demonstrated the time requirements involved in advancing our understanding of Arctic Ship Technology. If the horizon is set at the year 2000, and projects requiring high arctic class ships may be initiated before that date, then the time is short to develop the necessary design and operational expertise.

Fortunately, Canada is presently equipped with many icebreaking ships. These ships and their design and operations personnel offer an ideal opportunity to expand our understanding of Arctic Ship Technology. To ensure the necessary advances will be made, the present state-of-the-art must be understood and deficiencies should be addressed by a well structured research programme.

BIBLIOGRAPHY

1. "Canadian Energy Supply and Demand Summary and Technical Report", Sept. 1984.
2. "Mines and Mineral Activities", Indian and Northern Affairs Canada (INAC), 1983.
3. "MN1 Mines and Important Mineral of the Yukon and Northwest", Northern Resources and Economic Planning Branch, INAC
4. "Beaufort Sea Hydrocarbons Production and Transportation", Federal Environmental Assessment & Review Panel, July 1984.
5. "The Lancaster Sound Region 1980-2000", Green Paper, Indian and Northern Affairs Canada, January 1982.
6. "Industrial Development in the Eastern Arctic Study Area: A Preliminary Overview", C. George Miller, Institute of Local Government Centre for Resource Studies.
7. "The Lancaster Sound Regional Study Public Review", Indian and Northern Affairs Canada, November 1983.
8. "People, Resources and the Environment", Peter Jacobs, Indian and Northern Affairs Canada, August 1981.
9. "Canadian Frontiers...From Exploration To Development", Conference Papers, June 6-7, 1984, Calgary.
10. Various Annual Reports: Panarctic Oils Ltd., Imperial Oil Limited, Gulf Canada Limited.

2.3 Government Shipping Activities

The Federal Government activity in Arctic Transportation is concentrated in the following departments:

- Department of National Defence,
- Energy Mines and Resources,
- Indian and Northern Affairs Canada,
- Transport Canada;
 - . Coast Guard,
 - . Transportation Development Centre,
 - . Ports Canada.

The influence of these Departments on arctic development is substantial. For example, construction of the proposed Coast Guard Polar 8 could lead to resource developments which would not have occurred if an icebreaker of this high ice class was not available.

The Department of National Defence is about to begin construction of the New Warning System (NWS) to replace the DEW Line. The construction of 47 stations, 11 of which are to be manned, will result in substantial movements of construction materials and supplies into the Arctic, some by sea lift. This operation will likely be serviced by currently available tonnage. After construction, a resupply role will exist which may be supplied by ships depending on station location and cargo volumes.

Coast Guard Fleet Systems supervises the eastern Arctic sea lift which resupplies the Arctic communities and DEW Line stations. In 1984 a total of 49,000 tonnes of cargo were shipped north to thirty-five sites including seven DEW Line stations. This cargo was delivered by eight cargo vessels and five tankers; all relatively small vessels. The cargo was made up of 12,351 tonnes of dry cargo with the remainder being petroleum products. The level of shipment is not expected to change significantly and no new vessels should be required.

The Port of Churchill currently operates from early August to mid October with a throughput ranging from 300-800,000 tonnes. There is presently some discussion about extending the operating season. A season extension could give Churchill the advantage of handling more grain than is moved presently. This extension would be a matter of weeks and should not involve the use of high ice class ships.

3.0 PROBABLE ARCTIC SHIPPING SCENARIOS

Although all of the project proponents are enthusiastic about the likely success of their own project, some discretion must be used when considering the probable shipping requirements. The probable requirements are summarized on Table 3.1 and shown on Figures 3.1 and 3.2.

a) Nanisivik - Lead Zinc

Existing tonnage should be sufficient to move the concentrate from the currently defined ore body. Through further ongoing exploration the operator may locate sufficient reserves to produce beyond the five to eight years currently anticipated. Should this occur, existing vessels may have to be replaced.

b) Polaris - Lead Zinc

With production expected from this property beyond the mid 1990's, it is anticipated that new vessels will be required to meet the shipping requirement. It is not expected that vessel size or types will be different than those which currently service the mine.

c) Izok Lake - Zinc, Copper, Gold, Silver

Izok Lake is forecast to be the next mineral property to be developed. The lead and zinc concentrates from this property may be transported to the coast and shipped seasonally using a vessel similar in size and capability to the ARCTIC.

d) Henning Lake - Lead Zinc

The copper and zinc ore on this property also contains significant quantities of gold and silver. This ore may be moved to the west coast of Hudson Bay and then transported south on barges to Churchill or east to Europe on deep sea vessels. This will be a seasonal operation and the small quantities of ore will not require the construction of new vessels.

Should all four of these properties operate simultaneously then additional ships may be constructed. Depending on the volume, these operations may require the use of a more ice capable, larger vessel than the ARCTIC.

e) Bent Horn - Oil

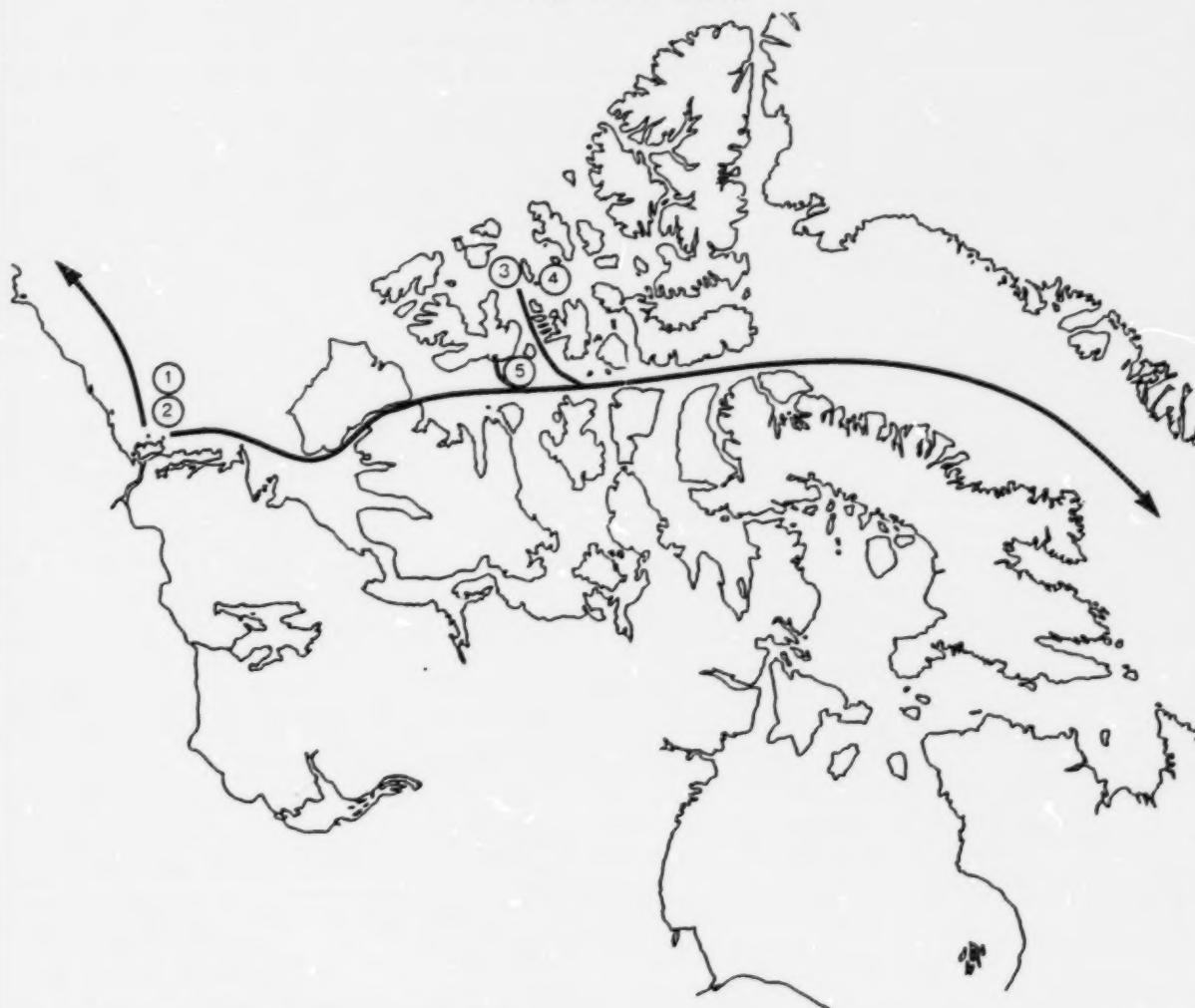
The only oil presently being shipped from the Arctic is from Panarctic's Bent Horn well. Although possible, it is unlikely that more than 500,000 bbls of oil will be shipped per year.

TABLE 3.1
PROBABLE ARCTIC SHIPPING REQUIREMENTS

LOCATION	CARGO TYPE	ANNUAL VOLUME (TONNES)	SHIPPING SEASON CONTEMPLATED	PROJECT LIFE
<u>MINERALS</u>				
a) Operating Projects				
Nanisivik	lead zinc	125-150,000	July - November	5-8 years
Polaris	lead zinc	225-300,000	August - mid October	15 years+
b) Potential Developments				
Heninga Lake	zinc, copper gold, silver	125-175,000	June - mid October	10 years+
Izok Lake	lead zinc	200-300,000	mid July - mid October	15 years+
<u>OIL AND GAS</u>				
a) Operating Projects				
Bent Horn	oil	13-70,000	August	3 years+
b) Potential Developments				
Beaufort Sea	oil	20-50,000	mid July - mid November	8 years+
	oil	4-6 million	year-round	10 years+
	oil	1-1.5 million	year-round	10 years+
High Arctic	oil	2-2.5 million	year-round	20 years+
	gas	3-3.5 million	year-round	20 years+

FIGURE 3.1

YEAR ROUND SHIPPING OPPORTUNITIES
TO THE YEAR 2000



	ICE CAPABILITY	VESSEL SIZE	SHIPS REQUIRED	SHIPPING SAFETY ZONE
BEAUFORT SEA OIL				
1. SMALL SCALE YEAR-ROUND	MULTI-YEAR	50,000 DWT	1	2
2. LARGE SCALE YEAR-ROUND	MULTI-YEAR	200,000 DWT	2+	2
HIGH ARCTIC OIL				
3. CISCO (SMALLER VESSELS)	MULTI-YEAR	100,000 DWT	2+	1
4. CISCO (LARGER VESSELS)	MULTI-YEAR	200,000 DWT	1+	1
HIGH ARCTIC GAS				
5. ARCTIC PILOT PROJECT	MULTI-YEAR	2 x 140,000 CU M	2+	6

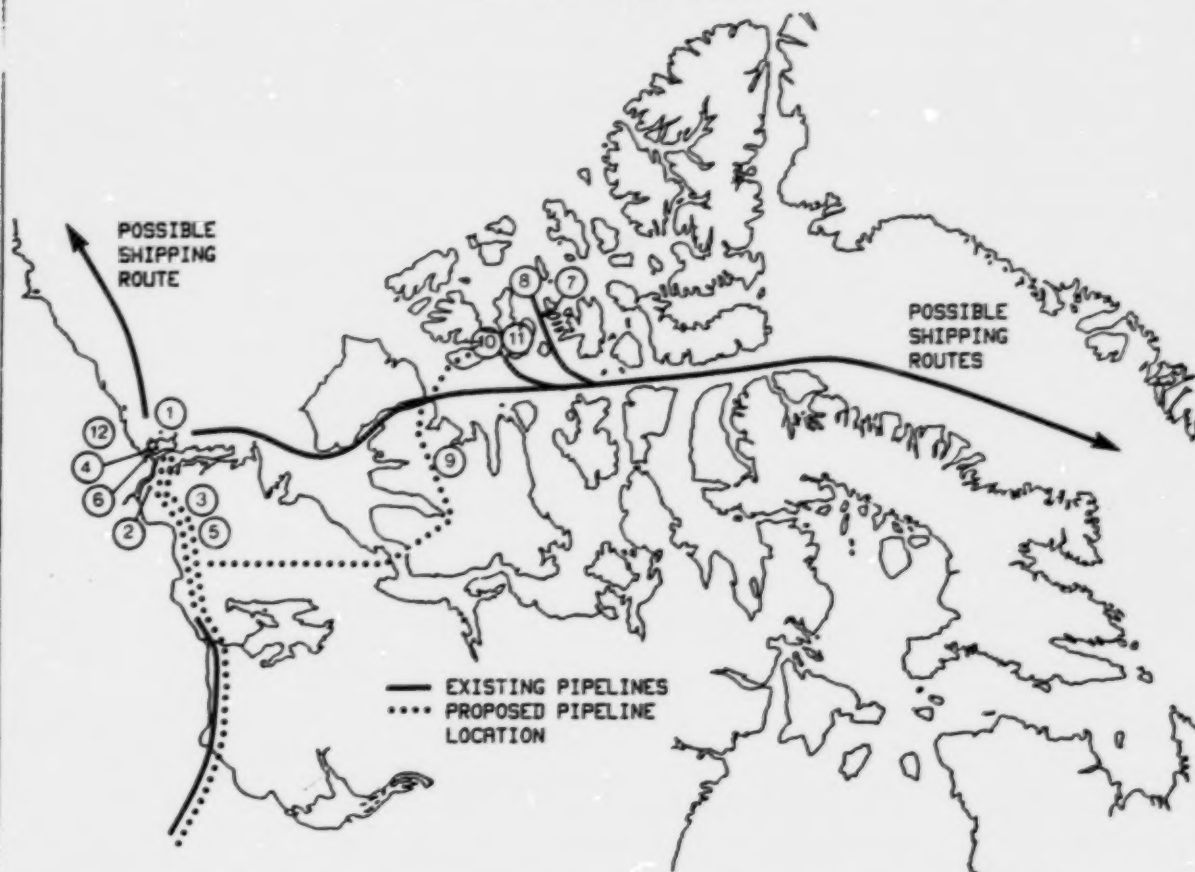
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TABLE 2.3 (continued)
CURRENT AND POTENTIAL OIL AND GAS DEVELOPMENTS
REQUIRING MARINE TRANSPORTATION

PROJECT NAME	OPERATOR/ PROPOSER	PROJECT LIFE	POTENTIAL SHIPS REQUIRED
<u>POTENTIAL DEVELOPMENTS</u> (cont'd)			
b) High Arctic			
Arctic Methanol	Gallager/Meyer and others	10 years+	existing tonnage
Arctic Pilot Project, Melville Island, NWT	Petro-Canada	20 years+	new Arctic class vessel
Cisco	Panarctic	15 years+	existing tonnage
Polar Gas	Polar Gas Project: TransCanada Pipelines Ltd.; Ontario Energy Corp.; Tenneco Oil Canada; Panarctic; Petro-Canada	20 years+	intensive resupply may require Arctic class vessel

FIGURE 2.6

POTENTIAL ENERGY DEVELOPMENTS
TO THE YEAR 2000



	PROJECT	PROPOSER
BEAUFORT SEA		
OIL DEVELOPMENTS	1. BEAUFORT PRODUCTION	ESSO; GULF; DOME
	2. NORMAL WELLS EXTENSION	ESSO
	3. MACKENZIE VALLEY PIPELINE	GULF; ESSO; DOME
	4. MACKENZIE VALLEY TOPPING PLANT	GULF; ESSO
GAS DEVELOPMENTS	5. POLAR GAS	POLAR GAS PROJECT
	6. MACKENZIE DELTA GAS PLANTS	ESSO; GULF
HIGH ARCTIC		
OIL DEVELOPMENTS	7. BENT HORN	PANARCTIC OILS
	8. CISCO	PANARCTIC OILS
GAS DEVELOPMENTS	9. POLAR GAS	POLAR GAS PROJECT
	10. MELVILLE ISLAND METHANOL	GALLAGHER AND OTHERS
	11. ARCTIC PILOT PROJECT	APP JOINT VENTURE PARTNERS
PORT DEVELOPMENT	12. KING PORT	MONENCO
		MELVILLE SHIPPING LTD